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FARM-WOODS MANAGEMENT
IN
SOUTHERN MINNESOTA

By John R. Neetzel

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FOREST SERVICE
Lake States Forest Experiment Station
University Farm, St. Paul 1, Minnesota
E. L. Demmon, Director

July 1949

FARM-WOODS MANAGEMENT IN SOUTHERN MINNESOTA

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FARM-WOODS MANAGEMENT IN SOUTHERN MINNESOTA [1]

By John R. Neetzel, Forester[2]

INTRODUCTION

Farm woods are an important but often neglected asset in southern Minnesota. In the 62 counties south of Lake Mille Lacs there are about two million acres of woodland, most of it on farms of which there are 137,000 in this area. In addition, thousands of acres have been planted to windbreaks and shelterbelts.[3]

Many Minnesota farm woods have been neglected because few owners knew how to manage them properly. The owners have lacked the necessary knowledge because much of the accumulated experience has never reached them. However, there has been considerable progress in woodland management during the past decade.

Many of the foresters who helped develop farm-woods practice in southern Minnesota have now gone into other work or have moved to other localities. As these foresters leave, much of the knowledge gained may be lost to southern Minnesota. With this in mind, several foresters who had had experience in southern Minnesota were contacted and their opinions were recorded.

Acknowledgement is made to the following technically trained foresters who have worked in the area and who have contributed freely to the ideas and observations presented here:

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[1] Compiled by the author based on his own observations and experience; on information obtained from Soil Conservation Service Foresters, Farm Foresters, Extension Service Foresters, Farm Leaders, sawmill operators, farmers, and others; and on available literature.

[2] This project was carried out cooperatively by the Division of Forestry, University of Minnesota, and the Lake States Forest Experiment Station.

[3] Based on "Forestry Terminology," Society of American Foresters. 1944. Windbreak--a wind barrier of living trees and shrubs maintained for the purpose of protecting the farm home, other buildings, garden, orchard, or feed lots. Shelterbelt--a wind barrier of living trees and shrubs maintained for the purpose of protecting farm fields.

Wilfred H. Lauer, Consulting Forester, Winona, Minnesota. (Formerly Farm Forester, Winona, Minnesota.)

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Lee K. Moore, District Conservationist, Soil Conservation Service, Red Wing, Minnesota.

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Hans Latvala, Soil Conservation Service, Fergus Falls, Minnesota.

Herbert G. Halverson, District Conservationist, Soil Conservation Service, St. Peter, Minnesota.

Einar Henrikson, Forester, Soil Conservation Service, Twin Valley, Minnesota.

Ray C. Cline, Farm Planner, Soil Conservation Service, Buffalo, Minnesota.

Dewey Hahn, Farm Planner, Soil Conservation Service, Jordan, Minnesota.

Parker Anderson, Extension Forester, University Farm, St. Paul, Minnesota.

Ray Wood, Assistant Extension Forester, University Farm, St. Paul, Minnesota.

Acknowledgment is also made to Donald P. Duncan, formerly Extension Forester of Kansas and now instructor in the Division of Forestry, University of Minnesota, for many helpful suggestions.

The writer is also indebted to many country agricultural agents, agricultural leaders, sawmill operators, farmers, and others who have supplied information on the early timber-resource history and general wood-lot problems, including utilization, in southern Minnesota.

This material, together with a review of available published information, has been summarized in this report to serve as a background for agricultural leaders and farm foresters interested in improving woodland practices in this area. It also provides a basis for formulating future research programs and for developing improved woodland management policies.

HISTORICAL

Woodland exploitation and management in southern Minnesota started with settlement by the first northern European immigrants, about 1840. Forest conditions and woods practices in their "mother countries" had impressed many of these early settlers with a deep respect for trees. As a result, the woodlands on the newly settled farms, except where they were cleared for crop and pasture, were seldom abused. If the homestead did not have a timber tract, in many cases a nearby forest area was divided into small wood lots. The Nerstrand Woods in Rice County is perhaps the best known example of such an area in southern Minnesota.

In the western Minnesota prairies, "tree claims" were settled in the "seventies" and "eighties" with areas up to 80 acres planted to trees. Most of these plantings, however, were small, probably averaging about 10 acres per farm.

On the timbered farms, part of the woodland was usually cleared to provide crop acreage. Before 1900 much of the timber cut for land clearing was heaped into piles and burned, sometimes destroying entire sections of timber at one time. The uncut woodland was often left more or less undisturbed except for light cuts of mature trees for fuelwood, fence posts, lumber, and other farm needs.

The fuelwood market required large quantities of timber during the early years of settlement. As an example, there are reports of long caravans of sleds carrying fuelwood from the Cleveland area to the flour mill, State hospital, and homes in St. Peter about 75 years ago. Wood was also supplied to the riverboats which operated on the Mississippi River and as far up the Minnesota River as Mankato. Most of this fuelwood came from land being cleared for crop or pasture.

By 1900, southern Minnesota hardwood lumber was finding its way into commercial markets in Minneapolis and St. Paul. Much of it was also being used locally for home construction. An elderly sawmill operator tells of cutting more than a million feet a year for many years near his home at Racine, in Mower County, where today there is little timber left.

Thus, during the 19th century, the woodland acreage in southern Minnesota gradually was reduced and the cleared land developed into farms. The timber left on the farm was generally not disturbed. Where the soil was deep and fertile, agricultural crops were certainly the best use for the land.

During early years of settlement, cattle were herded on grass meadows and open areas and were seldom allowed to run in the woods. About 1895, the dairy industry started to develop on farms which had previously been used largely for grain crops. The number of cattle increased and for want of pasture, they were turned into the woods. As fence wire became available at reasonable cost, larger areas of woodland were included in the fenced pasture and the abuse of the farm woods began. No factor has been more important in the deterioration of farm woodlands than the grazing of domestic livestock--mostly dairy cattle.

In the past, and even today, considerable timber on steep hillsides, along river bottoms or on soils of low agricultural value, has been cleared to go into crop and pasture land. Such practice is not necessarily poor wood-lot management, but may be poor judgment in the long-time land-use and farm-management program.

The woodland area in southern Minnesota is fairly well stabilized today, although some of it still includes potential cropland. Under wise management, timber on land suitable for cultivation will eventually be removed and the area put into crops. A somewhat similar area of land better suited to timber than crops has been cleared, and should eventually be restored to timber production, a long and difficult task. The "Conservation Job Ahead Study"[4] by the Soil Conservation Service, outlines the conversion needed. To accomplish this, tree nurseries must be developed and thousands of landowners must be encouraged to replant these lands to trees.

Prior to 1920 little or no public attention was given to the southern Minnesota farm woodland area and its problems. In that year the Division of Forestry, University of Minnesota, inaugurated a study of windbreak planting, primarily in the western part of the State. These planting studies have furnished much valuable information on survival and growth of many tree species.

In 1926, a state extension forester was employed and an active farm-forestry educational program was inaugurated by the Extension Service. However, one man dealing with forestry problems on several million acres of farm woodlands scattered over the entire State could do little more than scratch the surface.

In 1933 the Civilian Conservation Corps program made both manpower and funds available and a new era dawned in farm woodland and windbreak management. Also, the Soil Conservation Service program started in southeastern Minnesota in 1935. Several foresters were employed by these two agencies. For the first time, a considerable area in southern Minnesota was "exposed" to good forestry practices. Many wood lots were fenced against grazing; timber stand improvements were made in both young and old stands; woodlands received increased protection from fire; field shelterbelts and farm plantings were made; some supplemental planting and direct seeding were tried in areas where the forest had been depleted by fire and grazing; and local use of farm woodland products was demonstrated and encouraged.

4/ Typed compilation by the Soil Conservation Service for the organized Soil Conservation Districts. 1947.

Since 1935 these foresters (first in the CCC and later in the Soil Conservation Service) have done an excellent job of pioneering in the farm woodland field. About 1941, the woodland-management program faded with the discontinuance of the CCC. The farmer's wood lot is still considered by the Soil Conservation Service to be an important part of the farm plan but receives no special attention. Gradually the SCS foresters have been shifted to other areas or have been assigned as farm planners or District Soil Conservation Leaders. Little or no written record exists of the forestry work done, or the observations and accomplishments of these men. At the end of 1947, except for the two State Extension Service Foresters, no publicly employed foresters were working in Minnesota south of the Twin Cities.

In April 1948, a Farm Forestry project was assigned to southeastern Minnesota under the Minnesota Department of Conservation. Mr. Emil Kukachka was located at Faribault, Minnesota, to work in the surrounding territory. At the same time Milton H. Lemke was assigned to Cambridge, Minnesota, to work as Farm Forester in the surrounding counties.

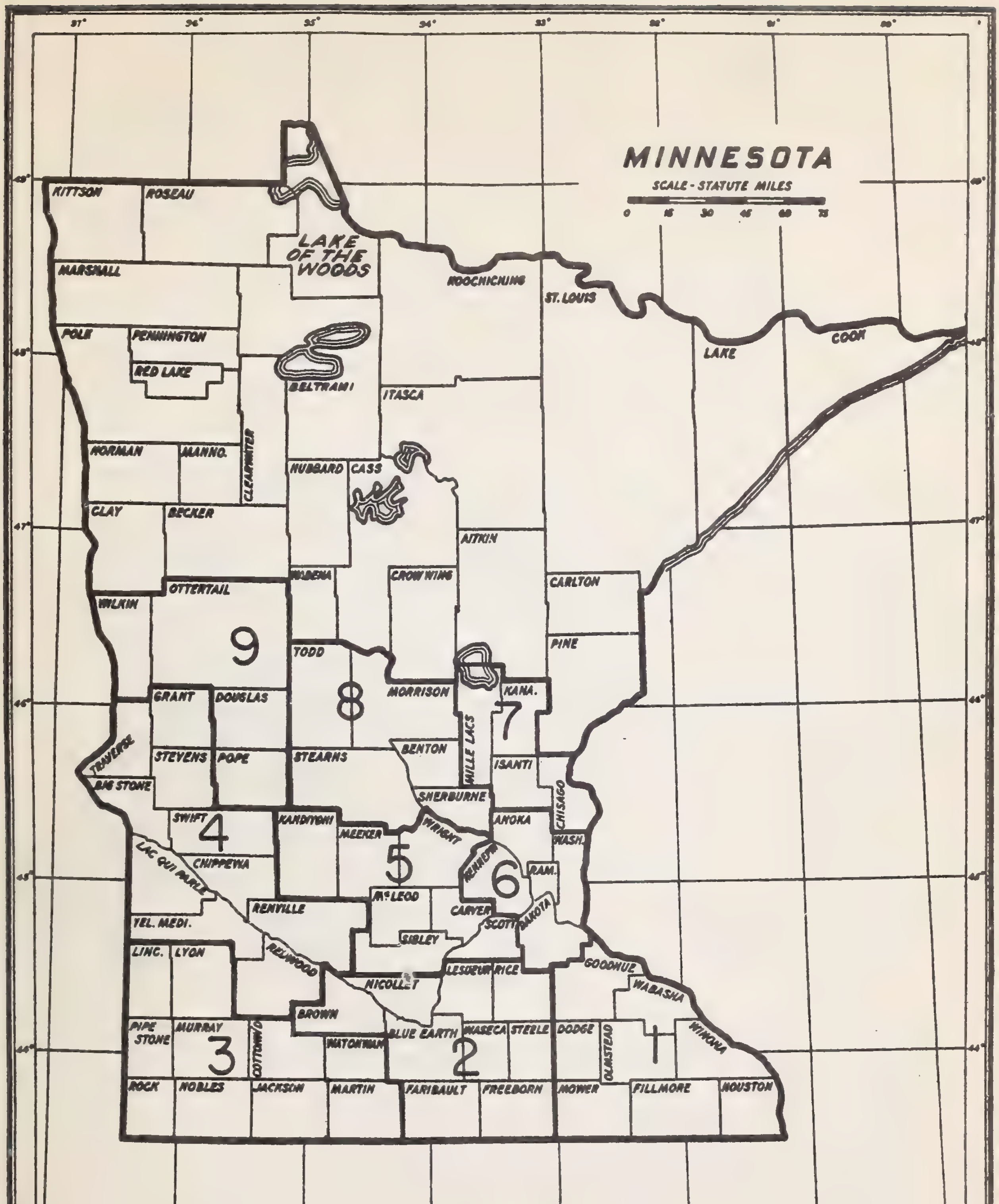
Since 1936 the Federal Agricultural Adjustment Administration (now Production and Marketing Administration) helped promote good farm-forestry practices through benefit payments for planting, plantation care, and timber stand improvement. Most of the payments have been made for planting and about 11,772,000 trees have been set out under this program.

FOREST CONDITIONS

The 62 Minnesota counties south of Lake Mille Lacs (see attached map) include 2,015,400 acres of farm woodland. This area has been divided into nine districts, each representing fairly uniform conditions:

District	Woodland area [1] (acres)	Proportion of total area (Percent)
1. Southeastern Minnesota	464,400	14.2
2. Mankato	148,629	4.6
3. Southwestern Minnesota	24,746	0.6
4. Upper Minnesota Valley	45,072	1.0
5. Big Woods	208,051	8.3
6. Twin Cities	142,652	10.6
7. Cambridge	214,569	17.2
8. Little Falls	477,690	17.4
9. Lake Region	289,591	11.1
Total	2,015,400	8.0

[1] Based on 1945 U.S. Census of Agriculture.



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The woodland is distributed between the major forest types recognized by the Forest Survey in southern Minnesota as follows:

Timber type	Percent of total
1. Northern hardwoods	27.1
2. Aspen	22.9
3. Oak	20.6
4. Lowland hardwoods	9.6
5. Tamarack	4.6
6. Scrub oak	1.0
7. Miscellaneous and noncommercial	14.2
Total	100.0

These timber types vary as to location, forest composition, characteristics, and relative importance. Only the northern hardwoods, aspen, oak, lowland hardwoods, tamarack, and scrub oak types cover sufficient acreage to be of economic importance.

1. Northern hardwoods are found on upland sites in southern, southeastern, and central Minnesota (largely in districts 1, 2, 5, 6, and 8). The principal species are sugar maple, basswood, red oak, American elm, and eastern hophornbeam (ironwood). Stands of all age classes are found although the majority are of saw-timber size. This is the most valuable timber type on farms in southern Minnesota.

2. Aspen stands in which this species makes up at least half the volume are found largely in the northern counties (districts 7, 8, and 9). Much of this aspen is unsuited to the soil or has been burned repeatedly, so that it is unlikely to produce anything better than low-grade pulpwood. A partial understory of balsam fir, pine, and inferior hardwoods is common.

3. Oak is a mixed type, characterized by white, red, and bur oak in association with sugar maple, basswood, and other hardwoods. It occurs mostly in the southeastern, southern, and east central part of Minnesota (districts 1, 2, and 6). It is similar to the northern hardwood type, except that oaks predominate. Most oak stands are from 70 to 75 years of age.

4. Lowland hardwoods, chiefly cottonwood, black ash, American elm, silver (soft) maple, and hackberry occur along many stream courses. This is a moist soil type. These trees, however, will not develop where the water is stagnant or where the ground is flooded for long periods of time. Trees in this lowland-hardwood type grow more rapidly than any other in the farm woodland region and are usually even aged within the stand. However, stands of several ages can often be found even on small areas.

5. Tamarack is a true swamp type. It is usually found in the northern areas (districts 6, 7, 8, and 9). Much of it is in small patches of lowland in farm pastures. Grazing has been severe; cutting of small posts and poles is common. In general, this type is understocked and in poor condition. Most trees are from 2 to 6 inches in diameter with a few scattered older ones which were not killed by the sawfly.

6. Scrub oak includes all of the oak species present in the area, but in a stunted or dwarfed condition. Bur oak is the key species; northern pin oak is also present. The type is generally limited to the southern half of the State on the dry, gravelly, and sandy soils (districts 1, 2, 3, 4, 5, 6, 8, and 9).

7. Miscellaneous and noncommercial forest land is found throughout southern Minnesota. It consists of heavily grazed and deforested areas where the stocking is too light to be considered as forest, and of small areas reserved for park or recreational use. Small patches of spruce swamp and pine are included in this classification.

Woodland Grazing

About 80 percent of the woodland area in southern Minnesota is grazed. In some cases the grazing is light and seasonal. On more than half the area, however, serious grazing damage is evident by the high "browse line" on the trees and shrubs, and the general lack of small trees and reproduction.

Grazing is more common in the upland types but has caused also serious damage in the lowland areas. More than any other factor, grazing has contributed to the present low stocking, poor size-class distribution, and inferior composition of the wood lots.

Owners of woodland now being grazed often plan to clear it. Grazing is a convenient and rather inexpensive method of starting the land-clearing project.

While the total timber area continues to decline in southern Minnesota, the area of timber protected from grazing is on the increase. This is a healthy sign, for this protected acreage is largely on land that should remain in timber.

Insects and Disease

No serious insect or disease infestations have occurred in the woodlands of southern Minnesota. There are, however, several forest insects and diseases which cause considerable damage.

Blister rust, which is a serious disease of white pine, has now spread throughout southern Minnesota. Old-growth pines which could be affected by the disease represent a negligible part of the timber type acreage and are being cut at a rapid rate. Natural white pine reproduction is seldom found. Control measures for the blister rust (removal of currant and gooseberry bushes) is hardly justified except in a few isolated cases. Because of this disease the planting of white pine on farms is questionable. Under no circumstances should white pine be planted within 900 feet of cultivated or native currant and gooseberry bushes.

Most oaks and aspen are affected by heart rot. This is especially true of trees in stands originating after fire or growing on sites not suited to their best development. The acceleration of growth through frequent cuts and the harvesting of crop trees at younger ages are suggested control measures.

The birch borer occurs in most birch stands, which, however, are relatively unimportant in this area.

Oak wilt appears to be very serious in some stands in southeastern Minnesota. Grazed and ungrazed areas seem equally susceptible to attack, which usually occurs on limited portions of a stand, but on these areas the kill is often complete. This disease deserves careful study as it may be an important factor in future oak stands.

Forest tent caterpillars and spring canker worms periodically defoliate northern hardwood species, especially sugar maple, basswood, and elm, over considerable areas. The understory of reproduction often is damaged seriously but the larger trees usually leaf out again after defoliation without apparent permanent harm.

Wildlife

Farm windbreaks or shelterbelts and wood lots are favorite refuges for pheasants during winter storms, and provide nesting places for those birds. The farm woodland is the natural haunt of cottontail rabbits, skunks, squirrels, and foxes. Many songbirds use the farm woods for nesting places and protection. Where larger woods occur along stream banks, they often are frequented by ruffed grouse, racoon, and deer. The importance of farm woodlands to game management, although recognized by specialists, deserves study.

FOREST RESEARCH FACILITIES

The first farm woodland research in Minnesota was undertaken by the Division of Forestry, University of Minnesota, about 1920. In 1935 the Soil Conservation Service put in some farm-forestry demonstration projects at Winona and Twin Valley. Shortly thereafter the Lake States Forest Experiment Station, in cooperation with the Divisions of Forestry and Engineering of the University of Minnesota, carried on limited research on the use of home-cut lumber on the farm.

At no time has the research program of all the agencies combined more than scratched the surface of woodland management problems. Considering the timber volumes, growth possibilities, and the need for trees in a sound soil-conservation farm program, southern Minnesota has never received adequate attention.

The following agencies have an interest in windbreak and woodland research in southern Minnesota:

Minnesota Department of Conservation, Pittman-Robertson program,
St. Paul 1, Minnesota (Wildlife habitat).

University of Minnesota, St. Paul 1, Minnesota
Division of Forestry (Farm windbreaks and home use of local lumber).
Division of Agricultural Engineering (Home use of local lumber)
Division of Agricultural Economics (land use)
Mayo Forestry and Horticulture Institute (tree improvement studies and Christmas tree production).

Lake States Forest Experiment Station, St. Paul 1, Minnesota (all fields)

Hormel Foundation, Austin, Minnesota (tree planting)

U.S. Fish and Wildlife Service, Winona, Minnesota
(Bottom-land hardwood management)

The following publicly owned areas offer possibilities for forest research:

Nerstrand Woods (Minnesota Conservation Department and Division of Forestry, University of Minnesota, St. Paul 1, Minnesota). Nerstrand, Minnesota (near Faribault and Northfield).

Whitewater State Park and Watershed (Minnesota Conservation Department), Winona, Minnesota.

Rosemount Research Center (University of Minnesota), Rosemount, Minnesota.

Upper Mississippi Wildlife Refuge (U.S. Fish and Wildlife Service), Winona, Minnesota.

Nine-foot channel navigation project lands - Southeast along Mississippi River from Hastings to Iowa line. (U.S. Army, Corps of Engineers) 180 E. Kellogg Blvd., St. Paul, Minnesota.

Winona City Forest, Winona, Minnesota
Waseca Agricultural Experiment Station (University of Minnesota), Waseca, Minnesota.
Morris Agricultural Experiment Station (University of Minnesota), Morris, Minnesota.
Alexander Ramsey State Park, Redwood Falls, Minnesota.
Beaver Creek Valley State Park, Caledonia, Minnesota.
Birch Coulee State Park, Morton, Minnesota.
Camden State Park, Lynd, Minnesota.
Fort Ridgley State Park, Fairfax, Minnesota.
Horace Austin State Park, Austin, Minnesota.
John A. Latsch State Park, Minnieska, Minnesota.
Kaplan Woods State Park, Owatonna, Minnesota.
Lake Carlos State Park, Carlos, Minnesota.
Lake Shetek State Park, Currie, Minnesota.
Minneopa State Park, Mankato, Minnesota.
Sibley State Park, New London, Minnesota.
Minnesota State Hospital, St. Peter, Minnesota.
Camp Ripley (U.S. Army), Little Falls, Minnesota.

Observations on windbreak, shelterbelt, and woodland management in southern Minnesota have been summarized under four headings, as follows:

1. Management of existing stands.
2. Utilization of harvested products.
3. Woodland grazing.
4. Wood-lot, windbreak, and shelterbelt planting.

Management of Existing Stands--Major Forest Types

Little actual research has been done on management of woodlands in southern Minnesota. The conclusions presented, therefore, are based upon experience elsewhere and impressions and observations of local foresters. While the general principles of management are known for the common forest types, much remains to be determined regarding the best treatment for variable conditions under which the types are found in southern Minnesota.

1. Northern hardwoods.--Experiments elsewhere in the Lake States indicate the general desirability of selective logging,[5] and resident foresters feel that this practice will also be acceptable for the type in southern Minnesota. However, the intensity of cutting and the frequency of logging operations will vary from place to place. The extent of the first cutting should range from very light, where little or no reproduction is present, to perhaps half the volume where only large mature trees are found and advanced reproduction, especially of the larger sizes, is present. The length of time between logging operations and the amount cut should be based on the rate of growth and amount of reproduction obtained following the first cutting. Present stands range up to 12,000 board feet per acre, but average about 2,000 feet per acre.

2. Aspen.--Since the trees in this type in southern Minnesota are usually of inferior quality, the aim of cutting should be to salvage a merchantable product. Cutting practices should also favor the conversion of the stand to more desirable species. This conversion can best be accomplished by harvesting the merchantable aspen and leaving seed trees of desirable species. This practice will usually mean about a one-half to two-thirds initial cut of the aspen. Enough shade should be left so that aspen will not sucker or sprout prolifically, and the stand left open enough to encourage the development of the present understory of better species which may be present. This will also permit additional seeding of desirable species. Aspen should be harvested at a relatively early age as it deteriorates rapidly. Where a sufficient stocking of desirable trees and reproduction is not available, it may be best to clear cut the

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[5] Removal of mature timber, usually the oldest or largest trees, either as single scattered trees or in small groups at relatively short intervals, commonly 5 to 10 years, repeated indefinitely, by means of which the continuous establishment of natural reproduction in the stand is encouraged and an uneven-aged arrangement of trees is maintained.

aspen and plant to other species. Such plantations would require release cuttings to keep them ahead of the aspen sprouts. Little is known regarding the best rotation for this type. Growth and yield information is needed for aspen grown in southern Minnesota.

3. Oak.--Most local foresters agree that the oaks in southeastern Minnesota should be cut selectively (single tree selection), somewhat like the northern hardwoods. Other foresters, especially those from outside Minnesota, believe that clear cutting is the best silvicultural practice for oak. In the western part of the State, near the prairie, fuelwood and posts are about the only products that can be obtained. There, clear cutting with a rotation6/ of 20 to 40 years, depending upon growing conditions, seems best.

4. Lowland hardwoods.--Cutting practices recommended for this type vary from clear cutting of pure cottonwood stands to a two-cut shelterwood7/ in areas of large soft maple and ash with little reproduction, to a light selective cutting, such as recommended for northern hardwoods. The presence of an advanced growth of shrubs, together with the hazard of developing a heavy sod that can only be broken through natural succession, makes this type difficult to manage. While the lowland-swamp species reseed readily in fields and along stream banks, they are hard to reestablish where the stand has been badly abused by grazing or poor cutting practices. Each stand must be given individual consideration with the two-cut shelterwood method perhaps the best all-around system.

5. Tamarack.--There is little or no experience in the management of this type. Where stands are undisturbed by grazing or fire, the periodic harvesting of merchantable trees is suggested. Clear cutting in narrow strips (up to two times tree height in width) appears to be a desirable method for securing natural regeneration in some stands. Where grazing has been practiced, a heavy underbrush and sod develop with little or no small tree growth.

6. Scrub oak.--Clear cutting is recommended with a rotation sufficient to produce 4-inch fence posts. The remainder of the stand will be usable for firewood. On the better sites where elm and sugar maple occur, it may be desirable to leave seed trees of these species for reseeding the area. However, unless these species grow in clumps, they may develop into wolf trees. It may be desirable to leave a few scrub oaks around these better species to help prune the lower branches of the desirable trees. A 20- to 40-year rotation should include all site conditions.

6/ The period of years required to establish and grow timber crops to a specified condition of maturity.

7/ Removal of the mature timber in a series of cuttings, which extend over a period of years equal usually to not more than one-quarter and often not more than one-tenth of the time required to grow the crop, by means of which the establishment of natural reproduction under the partial shelter of seed trees is encouraged.

7. Noncommercial.--Cutting practices for noncommercial stands are difficult to generalize. The aim should be to leave seed trees of desirable species and to harvest species which are not wanted in the future stand. In general, management should be by individual tree selection. In some cases it may not be economical to harvest scattered undesirable trees, and it may be better to kill them by girdling or by application of nonpoisonous chemicals.

In addition to cutting practices for older stands, there is need for timber-stand improvement in second-growth stands of all species. There is so little experience with younger stands in the wood-lot area, that general recommendations cannot be made. This phase of management should be given consideration when developing a research program for this region.

All recommendations for cutting practices in the farm wood-lot types are predicated on the assumption that the stand will be protected from grazing. A grazed wood lot cannot be partially cut without rapidly speeding up the destruction started by the livestock.[8]

No slash disposal measures other than reasonably close utilization are considered necessary for any of the wood-lot types. Logged-over areas are usually small, and logging slash when surrounded by open fields and uncut timber, does not represent a serious fire hazard. Most logging is in the hardwood types which are relatively fireproof.

The cutting practices recommended here are based on production for market, either through large-scale operations by the owner or from the sale of stumpage. Such cutting practices are needed wherever the wood lot is of sufficient size (40 acres or more) to justify practical operations. Most wood lots are, however, smaller, and the majority of the products harvested are used on the farm or sold in rough form. Here an individual tree selection, based largely upon annual or periodic growth, is recommended for all timber types.

The degree of cutting and the cutting method is usually dictated by the nature of the land itself. For example, on the steep hillsides in southeastern Minnesota, very light cutting is recommended to retard water runoff and to protect the soil from washing away. A similar stand in a cove or flat bottom land could be cut much heavier without destroying its value in soil conservation or for timber production. Likewise, where a wood lot is part of the windbreak, it should be cut lighter than a similar area located in some remote part of the farm.

Utilization

Utilization of the products harvested from farm woodlands of southern Minnesota is discussed under two headings:

1. Home use.
2. Markets for surplus material.

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[8] See "The Value of Farm Woodlands in Carver County, Minnesota," by William A. Duerr and C. H. Simonds, 63 pp. typed report, Lake States Forest Experiment Station. 1940.

Home Use

Surveys of farm-building requirements indicate that large quantities of lumber are used on the average farm. It has also been found that farm buildings are generally in poor repair and that many need replacement. The application of these general observations to southern Minnesota conditions has not been made and building needs and requirements may vary in the different farming areas within this territory. Also, no study has been made of the extent to which local lumber has been used for farm buildings or an estimate made of the anticipated use of local lumber in the future. In general, only a small part of building needs have been met by local lumber available from the farmer's wood lot. Most farmers own only a small acreage of timber (5 to 15 acres) and usually can use practically all it produces for lumber, posts, and fuel.

Lumber.--Home use of lumber was greatly stimulated during the war years. Some foresters believe this increased home use will continue. Others feel that farmers will obtain most of their needs from local lumberyards. Still others point out that the supply of usable timber in the wood lots is decreasing, and unless this trend is arrested through adoption of better forest practices, home consumption of timber will decrease.

In farm-building construction, substitutes such as tile, concrete, steel and aluminum are gradually replacing rough lumber made locally. These substitute building materials are being effectively advertised and sold. Lumber, especially home-cut lumber, does not have the benefit of advertising.

There is also a trend toward fewer and better buildings on farms. This calls for the use of better quality, well-manufactured lumber.

Local lumber would stand a much better chance of general use if it were sawn as well as that produced at the turn of the century. However, the skilled sawyers then active have passed on and the younger generation are interested more in speed of operation than in quality of work. Also, the frequent moving of mills often results in poor setting of the sawmills and poorly sawed lumber. Improved sawing methods are needed to restore the general acceptance of local lumber.

In the early days some buildings were built entirely of locally cut lumber, and carpenters were accustomed to this material. Today, at least part of the lumber for farm buildings comes from local yards and is imported from outside the territory. It is dry, accurately sized and surfaced, and carpenters prefer it to the local product.

Local lumber would be in much greater use today if it were accurately sawed, properly surfaced, and if information were available to users regarding strength and durability, nailing characteristics, etc., of the various species.

The better trees on many farm wood lots have been removed for lumber or special products, and grazing has deteriorated the remaining stands. Although a large acreage of timber remains, sawlog volume is decreasing. To improve composition and growth of most of these stands, the poorer trees should be culled out. Unfortunately the only outlet for this lower-grade material at the present time is on the farm.

Fence-post needs and uses.--Most fence posts used on Minnesota farms are of wood. In the prairie areas perhaps 15 to 20 percent steel posts are used in active fences, while in the cut-over and heavily timbered areas few, if any, steel posts are found.

Only a small percentage of the wood posts used are treated with chemicals, and those are mostly aspen and birch harvested and used in the northwestern part of southern Minnesota. White and bur oak, the chief species used for posts throughout the area, are seldom treated.

Fence-post consumption in the Red River Valley is on the increase. For many years large farms typical in this area have been used only for grain and potatoes, and few fences were needed. As these farms are brought under improved land-use practices by an effective soil-conservation program, more cattle will be raised and better crop rotations practiced. This diversified agriculture calls for partial fencing of the farm. It is anticipated that the number of fence posts used in this area will increase during the next several decades.

Elsewhere in Minnesota, the amount of farm fencing is decreasing. Most farms were once fenced on the exterior sides and had several cross fences. It is no longer necessary to fence against livestock from without. Fences are now built to keep livestock inside rotated pastures, which require less fencing. Gradually, fences not needed are being abandoned and torn down. The substitution of tractors for horses calls for larger fields and fewer fences. Electric fences, which require fewer and smaller posts, are also coming into wider use. The decrease in fences is offset partially by the adoption of contour cropping which tends to increase somewhat the fence mileage. However, where fences are now needed, many farmers prefer steel to wood posts because they are lighter in weight, easier to set, easier to pull and move, cause less damage to the wire, and are relatively safe for livestock during lightning storms.

Some wooden posts will always be needed for corner, brace, and gate posts, and around barnyards. A few wooden posts will be used in the steel fence to give it strength. Especially in fences required in contour farming, the general trend is toward less fence and more use of steel. Although the use of wooden posts may continue to decline, the development of inexpensive methods and equipment to peel, shape, sharpen, preserve, and drive wood posts would help offset this, particularly if treated wood posts could be produced more cheaply than competing material.

Fuelwood.--Fuelwood production and use, both on the farms and in small communities, has decreased steadily during recent years. Winona, Minnesota, for example, formerly had several active woodyards but now has only one small yard as an adjunct to a coalyard.

Many of the older farm and urban homes are being modernized and are installing central heating plants. Usually a stoker or an oil or gas furnace is replacing the several coal or wood-heating stoves. Minnesota is reported to have installed 100,000 new oil burners in 1947, and a considerable number of these were used in modernization of heating systems on the farms.

As rural electrification is extended, cook stoves using wood are being replaced by electric ranges. In areas not supplied by electricity, bottle-gas ranges and oil-burner heaters are replacing wood-burning stoves. Even the wood-burning heater for the stock water tank has been modernized by the use of coal, oil, or electricity as fuel.

Wood as a fuel, except on backwoods farms, is on the decrease and there is no evidence that this trend will be checked even by "hard times." Today, most farms and small urban communities do not even have facilities to burn the wooden boxes, discarded lumber, old fence posts, slabwood from sawmills, and the dead and dying trees which accumulate in shelterbelts. This usable fuel is largely left to rot or heaped into piles and burned as trash.

The development of a stove or furnace designed to use wood more efficiently probably would increase the use of wood for fuel, especially on farms with large wood lots.

Markets for Surplus Material

Some farm wood-lot owners have wood to sell, but usually do not know much about its volume or value and often sell it for less than actual worth. Often they make lump-sum sales, by area, with the buyer removing what he wants, leaving the area covered with slash. If the land is to be cleared for pasture or cropland, and a fair price is received, this is probably an acceptable sales practice.

Where the wood lot is to be managed for timber production, lump-sum stumpage sales are generally unsatisfactory. Foresters agree that product sales on the skidway or landing, with the farmer doing his own logging up to that point, are most desirable. In this way the owner receives the greatest cash return from his wood lot and markets its products like other agricultural crops. Such sales practices usually have been followed only in the few cases where farm-forestry assistance was provided. It is doubtful if product sales will materialize to any extent until more farm-forestry help is available.

"Product sales" will become more common when product specifications can be clearly defined and markets and price information made readily available to farmers. Such marketing services have been developed and maintained for most farm products, and some states have developed a marketing service for wood-lot products. This is desirable in securing improved timber management, and assuring a more stabilized production from the woodlands.

Included with a marketing service could be short notes on new equipment and improved methods of logging. Information on timber management could also be distributed in this way.

It is doubtful if even under good management and with a marketing service, all wood harvested could find a ready market. Most trees cut for stand improvement are suitable for chemical wood, pulpwood, or chips for a roofing or similar industry, but no such market exists in southern Minnesota today. Consequently, cuttings are only being made for products with a ready market. This results in removing the better trees and leaving the stands in poorer condition. One of the pressing problems to good woodland and windbreak management in southern Minnesota is the development of an active cash market for low-grade wood. One or more new industries using low-quality material might well be permanently established in this area.

Not all surplus wood is in the form of decadent trees and inferior species. There is, today, a considerable quantity of high-grade basswood, sugar maple, ash, and elm, suitable for veneer mills producing a high-grade product. These veneer logs command a high price and make woods operations more profitable.

Grazing by Domestic Livestock

Grazing by domestic animals and poultry is the most harmful practice permitted in the farm shelterbelt and wood lot. Foresters agree that livestock must be kept out of the timbered area as the first requirement of good forest management. The comments which follow are based largely upon experiments conducted outside of Minnesota or on local observations rather than research.

Damage by Forest Types

The oak forest appears to be harmed by grazing more than any other timber type, because of the scarcity of advanced reproduction even in undisturbed stands.

The northern hardwood type suffers somewhat less from grazing than the oak; and the bottom-land hardwood type appears to be least affected. Possibly the damage to these latter types is as great as in the oak forest, but because of more prolific seeding the trees in the mixed-hardwood and bottom-land hardwood types have a greater power of recovery.

In the bottom-land type, the dense brush cover restricts its use by cattle and gives reproduction a better chance to develop. The occasional flooding in this type discourages grazing and creates a favorable seedbed for such species as cottonwood, silver (soft) maple, elm, and ash. The brush and second-growth timber helps to maintain forest conditions, and restricts sod development.

Damage According to Tree Species

Damage to reproduction and small trees varies considerably for different species. Grazing appears to have little effect upon juniper, eastern hophornbeam (ironwood), walnut, and hickory. Most foresters class the damage to elm, cottonwood, butternut, and aspen as mild. Most serious damage from grazing is to the oaks, basswood, and sugar and silver (soft) maples.

Kinds of Animals Most Damaging

Most observers agree that all kinds of livestock, if in large numbers, are harmful to woodland.

Years ago, horses probably were the "number one" enemy of the woodlands. Today, there are so few horses that they are not an important factor in grazing damage.

Sheep are believed to be most harmful, with cattle ranking a close second.

Poultry, especially turkeys, are often destructive to the farmstead shelterbelt, although in some cases they help by cropping the weeds and grass. The area they affect is limited to a small zone near where they are housed.

Hogs, if properly "rung" usually will not do much damage, and may even be helpful by periodically stirring up the soil and developing a more favorable seedbed. Continuous pasturing of hogs would, however, be harmful.

Recovery of Grazed Areas

More than 80 percent of the woodland area of southern Minnesota is grazed. According to the 1945 Census of Agriculture, this practice had about reached its peak and the protected acreage showed an increase for the first time since records were available.

The important question now is how to repair the damage done in grazed stands, and how rapidly they can recover.

If a grazed wood lot is protected against livestock, some reproduction can be expected the first year. In many cases, however, the stocking of desirable trees is too low to assure ample reseeding.

Grazed wood lots are generally considered satisfactory both for field planting and direct seeding of some of the nut species. Before planting or direct seeding, most foresters agree the land should be protected and lie idle for several years. This will result in partial establishment of shrubs and herbs, and a decrease in heavy grass sod so harmful to forest plantations. Where protection from grazing is complete, natural reproduction will often eliminate the need for planting.

Types of Grazing Damage

Grazing of a wood lot by domestic livestock results in three general types of damage: (1) Destruction of plant life and forest environment; (2) browsing of young reproduction; and (3) trampling of the soil which damages its structure and water-holding capacity and harms surface tree roots.

It is generally agreed that the greatest damage from grazing comes to the small trees, ferns, and herbaceous growth that cover the forest floor. This permits the leaf litter and top soil to dry and in general alters forest conditions. When the rains fall they pack the soil and water that would have seeped into the ground runs off.

As grazing continues, more young trees are eaten and if the grazing is sufficiently intense even trees up to several inches in diameter may be ridden down, defoliated, and destroyed.

Stock movements through the wood lot in search of a meager supply of forage results in much trampling of the soil, destroying its top structure. Coupled with the removal of the herbaceous growth, the top layers of soil dry out, and soon grass begins to spread into the woods.

Where hillsides are pastured, trampling takes on another aspect. The livestock walking around the hillsides and up the valleys make paths which cover a considerable percentage of the forest floor. They pack the soil and prevent

the ready penetration of rainfall. In times of heavy rains, these paths become small streams which erode the soil. As the waterflow increases, erosion also increases, and these paths often form gullies.

"Grass is where it may be found"--is usually the trouble with the grazed wood lot. Even an ungrazed wood lot contains some good food. The livestock, if they do not have ample improved pasture, will use this woodland browse which is nearly as valuable as grass from an ordinary pasture. The main difference is that this browse is not sufficiently dense to supply ample forage without considerable travel and effort by the livestock. They actually lose weight in a wood lot with plenty of scattered forage available; whereas in an improved pasture, cattle obtain sufficient food in a few hours of grazing and can then rest for long periods.

One difficulty in controlling woodland grazing lies in the confusion between a wooded pasture and a pastured wood lot. The pastured wood lot is generally not very good pasture and pasturing is very destructive to the trees and reproduction. If the wood lot is on land that should be cleared for pasture or cropland, this pasturing may be a desirable step in the clearing process; but where land is to remain in timber, cattle should be excluded.

A pasture with some trees is desirable. Livestock need shade and a few trees do not harm good pasture. Most farmers think of all of their woods as a wooded pasture, when in reality part of it should be developed into an improved pasture with a few trees left for shade and the remainder protected from grazing.

Grazing of Plantations

The most serious grazing injury to coniferous plantations results from compacting of the soil by trampling. However, where browsing of coniferous seedlings is excessive the trees are often deformed and permanently damaged. Sheep do more damage than other animals.

Hardwoods, even with heavy browsing, have remarkable ability to recover when given protection. Light grazing in plantations helps to reduce grass and weed competition, retards rodent damage, and lessens the fire hazard.

After weighing advantages and disadvantages of grazing of plantations, complete protection is recommended.

Based on observation and experience, fencing of wood lots or plantations is not recommended. However, all pastures should be fenced. (The wood lot should not be a part of this pasture.) If wood lots or plantations are not fenced they will not be subjected to concentrated grazing. There may be light grazing by cattle running in the adjoining corn stalks or meadows late in the fall, but this will be less harmful than heavy grazing which almost always occurs in fenced woodlands.

Planting

Wood-lot, windbreak, and shelterbelt planting will be discussed under five phases: (1) Seed, (2) nursery practice, (3) coniferous planting, (4) hardwood planting, and (5) care of young plantation.

Seed

Seed production of hardwoods in southern Minnesota has had little attention. Some systematic notes have been taken for a limited area near the Soil Conservation Service nursery at Winona, Minnesota. Elsewhere foresters have made only a few casual observations.

Three important tree species (green ash, boxelder, and black locust), which often hold their seed until late in the winter, have been found to produce abundant seed crops at rather frequent intervals. Oaks and elms also produce good seed crops every few years. Black walnut, butternut, hickories, and basswood periodically produce abundant seed crops on some trees while others are barren. Only infrequently do these latter species produce seed abundantly on all trees.

In general it has been observed that trees in dense stands produce less seed than those in park-like stands. Since many southern Minnesota woodlands have been grazed heavily, many trees are open grown and ideal for seed production.

Experience at the Soil Conservation Service Nursery at Winona has led to the following recommendations for the collection of tree seed:

1. The source of seed should be such as to assure winter-hardy high-quality stock.

2. The area around Alma and Fountain City, Wisconsin, on the east shore of Lake Pepin, is considered excellent for collecting juniper seed.

3. To assure hardiness, American elm seed should be collected from the Red River Valley in northwestern Minnesota or North Dakota, or from other hardy sources.

4. Green ash seed should be collected from the "pot hole" district in western Minnesota. Seed collected from this area produces stock fairly immune to leaf rust, which has as its alternate host the slough grass in small bogs.

5. An annual seed-production survey and the establishment of permanent seed-collection areas throughout Minnesota is essential to an adequate nursery and field-planting program.

Nursery Practice

Experience of the Soil Conservation Service suggests the following:

First and most important is a seed supply to cover a minimum of two years' nursery needs. For oaks, walnuts, and similar species, which produce seed at 3- to 5-year intervals, a larger supply of seed is desirable.

Nut species generally should not be grown in the nursery. Oaks, hickories, walnuts, and butternuts should be directly seeded on the planting area. Best results are obtained with spring planting using stratified seed.

Cottonwood can be grown in the nursery from seed or rooted cuttings. Due to difficulty of controlling proper moisture conditions in the seedbed, however, nursery production from seed is usually not too successful. To assure a good stand it is necessary to maintain adequate moisture conditions of a "fog" nature during germination and establishment. Cottonwood seeds grow readily on sand bars and abandoned fields along river bottoms. The leasing of naturally seeded areas and lifting the wild stock for planting, or the leasing of land in a favorable location and planting cottonwood is recommended.

Conifers should be transplanted in the spring. Fall transplanting of conifers when necessary and where adequate irrigation facilities are available should be completed prior to September 1 to give the root system a chance to make fall growth before freezing weather.

Hardwood transplanting is generally not needed.

Nursery stock should be available for farm planting early in April and the tree-planting peak will usually be passed by the third week in April.

Coniferous Planting

Many foresters in southern Minnesota feel that conifers are important in windbreak, shelterbelt, and wood-lot plantings in this area. However, conifers do not survive as well as hardwood species, such as green ash and American elm, and it is doubtful if their use should be expanded. Conifers make a better winter windbreak than hardwoods, when used in narrow belts. Most observers agree that plantations with hardwoods and conifers in mixture are less likely to be grazed and have more chance to receive cultural and release work.

Spring planting generally has given better survival than fall planting. The difficulty with fall planting seems to lie partly in the practice of planting too late. Fall field planting is especially hazardous in Minnesota due to normal dry conditions during this time of year. If fall planting is done, the stock should be set in the field by September 1 to give the root system a month or so to develop before freezing weather. August is generally very dry and is also a busy month for farmers, so it is doubtful if any large-scale planting program could be developed then, although small-scale fall planting would ease the pressure in the spring. Except on sandy soils, stock planted late in the fall often suffers from frost heaving. In general spring planting for all tree species seems most desirable.

Conifers develop best on soils that are neutral or slightly acid. Conifers commonly planted in southern Minnesota include the following:

White pine.--White pine has been used extensively, except in the extreme southwestern counties. Survival has been spotty, ranging from very good to poor. Trees which have survived usually have made good growth. On the average, 2-2 stock seems best. Since white pine blister rust is common throughout Minnesota and eradication of Ribes is expensive, this species is not recommended except for areas that are relatively free of Ribes. Also, to avoid serious injury from the white pine weevil, this species is best planted under stands of hardwood, such as oak or aspen, and given later release. In good hardwood stands, white pine underplanting is not recommended.

Red pine.--Red pine survives well and develops somewhat better than white pine. Planting stock recommended is 2-1 or 2-2. This species is recommended for all except the extreme southwestern counties, but it should not be planted on the heaviest soils, nor beneath hardwoods or white pine stands.

Jack pine.--Jack pine has shown good to excellent survival and growth where used on the lighter soils without overhead shade. It is by far the best of the pines for reforestation and windbreak planting in southern Minnesota. Although 2-1 stock is recommended for general use, 1-1, 2-1, 2-0, and 2-2 stock have all been used successfully. Jack pine should not be planted on the heavier soils in southern Minnesota.

Austrian pine.--Austrian pine (2-1 and 2-2 stock) has been used to a very limited extent. Neither survival nor growth has been satisfactory. It is doubtful if this species should be recommended. It appears to have the best chance of survival in the extreme southeastern part of Minnesota. This species must not be planted beneath existing trees.

Scotch pine.--Scotch pine, using 1-1, 1-2, or 2-0 stock has been used in all parts of southern Minnesota, and has been a close second to jack pine in survival and growth. Stock smaller than 2-0 is not recommended. The Riga variety or other races with similar hardiness and good form, should always be used. Underplanting with this species is not recommended. Rabbit and mouse damage is common. Winter injury during 1947-48 was especially severe on Scotch pine of southern and central European origin, although the Riga variety from Latvia and Scandinavian races were quite resistant.

Western White (Black Hills) Spruce.--This species has not been used to any extent in past planting programs and is not recommended by most foresters. It may have some promise for the western counties.

White spruce.--White spruce (mostly 2-2 stock) has given fair to good survival, but only fair growth. In general this species has been used for underplanting or in mixture with rapidly growing hardwoods, which resulted in a dense overstory. Where this species has had freedom from overhead competition it has done well. Future plantings should be limited to the heavier soils and to areas relatively free of overhead cover.

Norway spruce.--Norway spruce has shown good survival and good growth. Recommendations are to use 2-1 or 2-2 stock, especially in windbreaks and other plantings throughout the area. This species should not be used for underplanting. Some races suffered considerable damage during the 1947-48 winter.

Juniper.--Juniper (red cedar) has been used to a considerable extent over the area. Survival has been spotty, ranging from fair to excellent. Growth, on the other hand, has been slow and seldom rates more than fair when compared with hardwoods. The best stocks seems to be 2-0, 2-1, or 1-1. Juniper does well on soils with a relatively high lime content. Since this species is an alternate host of the cedar-apple rust, it is not recommended in the apple-growing area.

Ponderosa pine.--This species has had only limited use, but some foresters believe it has a good chance to succeed, especially in the Red River Valley. 2-2 stock is recommended. However, heavy winter damage during 1947-48 indicates that the species may not be very hardy under Minnesota winter conditions of unusual severity.

Hardwood Planting

It is estimated that from 60 to 75 percent of all tree planting in southern Minnesota should be with hardwoods.

If a farm program of planting for game management develops, the proportion of hardwoods may be increased, since they furnish adequate wind protection, ideal cover, and more food than the coniferous species.

Hardwoods are planted as 1-0 or 2-0 seedlings or rooted cuttings. In several cases, as with the nut species, direct seeding appears better than planting with nursery stock. By properly stratifying the seed and planting in the spring, considerable rodent damage can be avoided.

Recommendations for each of the hardwood species, based upon the observations of several foresters follow:

Green ash.--For Minnesota planting it is important that seed be collected from rust-resistant trees from the "pot hole" area in western Minnesota. Survival of 1-0 or 2-0 stock is generally excellent with growth good. This species is recommended for use throughout this area on the better soils.

White ash.--White ash has not been extensively used, but it seems to be similar to green ash in characteristics and growth. Excellent survival and good growth of 1-0 or 2-0 stock can be expected on suitable sites, avoiding the extreme western and southwestern Minnesota counties.

Boxelder.--This species has had only limited use--mostly in the prairie area. The wood is of low value for fuel and posts, and seldom reaches a size to make lumber. The limbs and branches are brittle and break easily in storms. It shows good survival with 1-0 stock and makes excellent growth. In the opinion of several observers, this species should be given greater consideration, especially in the establishment of windbreaks, to be replaced later by more desirable and longer-lived species.

Cottonwood.--Cottonwood has been used extensively in southern Minnesota. Unrooted cuttings have not given very good survival and are not recommended. Rooted cuttings and 1-0 seedlings have survived and grown excellently. Because of the short life of the seed and the difficulty of maintaining proper moisture conditions in the seedbed, this species has not done well in the nursery. Usually, however, wildlings can be found in dense numbers on sand bars in the rivers, or on abandoned fields following spring floods. This is the cheapest and most satisfactory source of cottonwood planting stock.

American elm.--Good survival has been obtained using 1-0 or 2-0 stock, but growth has been only fair to good. To assure frost hardiness, it is necessary that seed be obtained in a northern area, such as the Red River Valley or North Dakota. Elm produced in the Winona nursery

from locally grown seed is seldom satisfactory in western and northwestern Minnesota.

Hackberry.--Hackberry (1-0 and 2-0 stock) was used to a considerable extent by the Soil Conservation Service in mixed plantings in southeastern Minnesota, from 1935 to 1940. Early survival was good but growth during the first few years was so slow that further use was not recommended. Examination of some of these same plantings in 1947, after about ten growing seasons, showed that hackberry responded well during the past few years and had overtaken, and, in some cases passed, competing hardwood and coniferous species in size. It appeared to be extremely hardy and rugged. The root systems were well formed and appeared to be as effective as black locust in controlling gully erosion. It is doubtful if the species should be used north of a line extending west of the Twin Cities through St. Cloud and Alexandria. It should do well in the windbreaks and shelterbelts in the southern and southwestern counties.

Black locust.--Black locust has been used extensively for gully planting by the Soil Conservation Service in southeastern Minnesota. The survival of 1-0 and 2-0 stock has been good to excellent. The growth varied from poor to excellent. In general the species has been very successful in stabilizing gullies. Often the trees were spaced 4x4 feet or farther apart. In most cases planting was on west or south slopes where erosion is most common. Under these conditions, the locust borer has been a pest on the young trees. Frost damage is common. These two factors often make the individuals in entire stands look more like large shrubs than trees. This species likes a neutral or basic soil, with plenty of moisture but good drainage. Dense stands, which shade the stems, discourage the locust borer. This insect is also less common on north and east slopes. In plantations some stems appear to be hardy and more vigorous than their neighbors. The selection of hardy strains planted densely on northerly exposures or on flat well-drained neutral soil should produce a good crop of durable fence posts in from 8 to 12 years.

Sugar maple.--Sugar maple, using 2-0 stock, has given good survival but poor growth. It is doubtful if the species should be used in open plantations, but it may have a place in underplanting where some shade is available. This species may not be suitable for the standard windbreak, but should be considered for wood-lot planting as the merchantable trees yield a valuable wood product. Once established in an ungrazed wood lot and developed to seed-producing age, the species soon becomes well established by natural reproduction. This species should be planted on good soil and under partial shade.

Silver (soft) maple.--This species has not been planted extensively of late years, although a considerable amount of pulled stock from the river bottoms was used during the early days in establishing windbreaks and tree claims in the western counties of Minnesota. 1-0 or 2-0 stock is recommended. On suitable sites, good survival and good to excellent growth can be expected. More extensive use of the species on river bottoms and in shelterbelts is recommended.

Willow.--Rooted cuttings of willow have given good to excellent survival and excellent growth throughout southern Minnesota. Greater use of the many species and varieties of willow, especially as a snow catch in field windbreaks, and as a nurse crop in establishing farmstead windbreaks and field shelterbelts is recommended. *Salix purpurea* (varieties *lamertiana* and *gracilis*) are low-growing species which have been used only experimentally but seem to offer great promise for the snow-catch portion of the windbreak.

Black walnut.--Black walnut, planted as 1-0 stock, has given good survival, but only fair growth in wood-lot plantations. The tap root is cut in lifting operations in the nursery, and the tree does not recover rapidly, if ever, from this shock. Seed spots have given only fair survival due to rodent damage, but the seeds that were missed by the squirrels produce seedlings that put on much better growth than the 1-0 nursery stock. Seed spots are preferable for this species if effective rodent repellents can be developed. This is the most valuable tree growing naturally in southern Minnesota, and deserves greater consideration on well-drained sites in both the wood-lot and windbreak planting programs. Stratified seed should be used in all walnut and butternut planting.

Butternut.--Growth and survival observations and planting recommendations are the same as those for walnut. This species, however, is not as valuable and does not warrant high preference in a planting program.

Oaks.--Oaks have not been raised to any extent in nurseries, so field observations were not available. It is the general opinion that these species, and also the hickories, should be grown in seed spots in the field. The development of a satisfactory rodent repellent to use on a seed is a major problem.

Siberian peashrub (*Caragana*).--This species has been used to a considerable extent as a snow catch in the Red River area and the extreme western counties of Minnesota. Good survival and growth can be expected with 1-0 stock. Grasshoppers and blister beetles have done severe damage in some plantations. Grazing by livestock seems to be more harmful than to ash, plum, and other windbreak and shelterbelt species.

Wild plum.--Wild plum (1-0 stock) has been used to a limited extent in the extreme western counties of Minnesota. Both survival and growth have been good. The species is recommended especially as a snow catch. Its dense growth is especially favorable for wildlife, such as pheasants and rabbits. The flowers in the early spring are attractive and the fruit maturing in late summer is showy as well as edible.

Russian-olive.--Russian-olive has been used fairly extensively in southern Minnesota and proved satisfactory. Excellent survival and good growth has been obtained with 1-0 stock. Greater use of this species is recommended for shelterbelt planting, although it should not be used on light acid soils.

Lilac.--Lilac has been little used in Minnesota. Where tried, 1-0 and 2-0 stock has given good survival but it is a very slow grower. This species makes a dense, hardy "snow catch" and is recommended for more extensive use in shelterbelts. The floral beauty of the species during the late spring is a good selling point.

Tatarian honeysuckle.--This shrub has been used to a limited extent in some windbreaks. It has shown good survival and made satisfactory growth. It has an attractive flower and a showy fruit liked by the birds. This species should have greater use in windbreak and shelterbelt planting, especially as a "snow catch."

Basswood.--This species has not been grown extensively in nurseries, probably because of the difficulty in securing germination. There are many examples of excellent field germination and growth, and the tree should have more consideration in woodland planting programs. Basswood is a fast-growing tree, ranking second only to cottonwood. In stumpage or log value it equals any species except possibly walnut.

Siberian elm.--Siberian elm (often erroneously called Chinese elm) has been used extensively throughout southern and western Minnesota in windbreak plantings. Survival of 1-0 and 2-0 seedlings has been good to excellent and early growth is rapid. In 10 years the trees often reach diameters of 6 inches and heights of 10 to 15 feet. From then on the tops break up easily under snow and ice, and the trees suffer severe winter injury. The species may have a temporary place in a new windbreak but certainly should not be considered as a part of permanent windbreak planting.

Care of Young Plantations

Many young plantations fail for lack of cultivation and release or because of insects or disease. Others start out satisfactorily but grow slowly because of competition. Most plantations fall short of ideal development because of failure to thin and prune, and protection from instects and disease. Since most plantations have not received much care after the first year or two of cultivation, it is difficult to make observations and obtain information of development under ideal conditions. The following disccussion is based almost entirely upon observation.

Cultivation.--Good cultivation, both between and within the tree rows, is probably the biggest factor affecting early survival and subsequent growth in farm plantings. Weed competition, especially from quack grass and other sod, has been severe in many wood-lot, windbreak, and shelterbelt plantings. Studies should be made of methods to combat this weed competition, particularly in the Red River Valley area.

Rodent control.--Mice and rabbits are particularly harmful to many plantations. Their occurrence may be closely correlated with lack of cultivation and a heavy grass sod. Pocket gophers sometimes damage the roots of the young trees. The relation of rodent population and damage to plantation deserves study with special emphasis on the development of control measures.

Grazing.--This subject has been covered in previous sections of this report, but the need for protection from grazing should be emphasized again. Except possibly to reduce the fire hazard by removing some of the grass, which might otherwise burn over in the case of fire, there is no indication that grazing of livestock ever contributed anything to improve survival or growth of planted trees in the area.

Fire.--Fire in the woodland has not previously been discussed since most forest timberland receives relatively good protection. Some burning occurs along railroad rights-of-way, especially in the oak type and the cut-over areas in districts 7, 8, and 9. Plantations, especially when not properly cultivated during the first few years, often present a considerable fire hazard until the crowns close and shade out the under vegetation. The farmer is usually proud of his plantations and gives them better fire protection than the rest of his woodland or windbreaks.

Thinning.--Tree crowns in many plantations soon close in and become crowded. This produces thin whip-like stems which grow slowly and are subject to wind and snow breakage. The proper time to thin such plantations and the degree of cutting is generally not known and deserves study.

Liberation cuttings.--During the early years small planted trees should be released from competition by frequent cultivation. Most stands are of mixed species, usually by rows. As these develop, certain species, such as cottonwood, grow more rapidly, and if left to develop naturally may crowd out slower growing pines, spruce, oak, basswood, etc. There are many examples of such crowding either by other planted trees or by native species established on the site. Information is needed on the proper cutting practices to use in such stands and the desirable size or age when operations should be started.

Pruning.--As the plantation develops the lower part of the boles of the trees become covered with dead limbs. Where special products, such as fence posts, poles, or logs, are desired it may be profitable to prune the crop trees to obtain smooth stems. In some cases pruning of larger trees would liberate younger individuals. Pruning of farm-woodland trees deserves study.

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